



October 1987  
Revised January 1999

# MM74C908 Dual CMOS 30-Volt Relay Driver

## General Description

The MM74C908 is a general purpose dual high voltage driver capable of sourcing a minimum of 250 mA at  $V_{OUT} = V_{CC} - 3V$ , and  $T_J = 65^{\circ}C$ .

The MM74C908 consists of two CMOS NAND gates driving an emitter follower Darlington output to achieve high current drive and high voltage capabilities. In the "OFF" state the outputs can withstand a maximum of  $-30V$  across the device. These CMOS drivers are useful in interfacing

normal CMOS voltage levels to driving relays, regulators, lamps, etc.

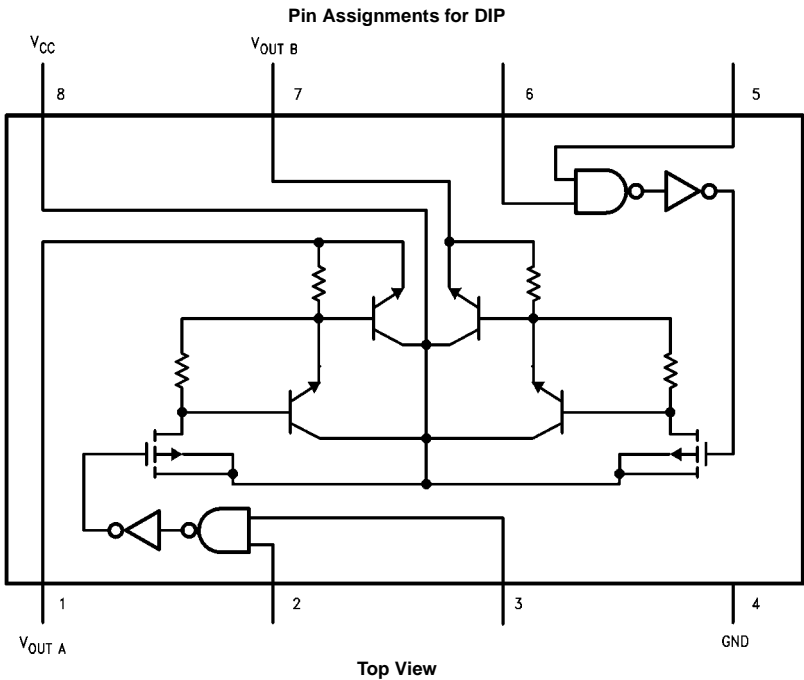
## Features

- Wide supply voltage range: 3V to 18V
- High noise immunity:  $0.45 V_{CC}$  (typ.)
- Low output "ON" resistance:  $8\Omega$  (typ.)
- High voltage:  $-30V$
- High current: 250 mA

## Ordering Code:

Order Number	Package Number	Package Description
MM74C908N	N08E	8-Lead Plastic Dual-In-Line Package (PDIP), JEDEC MS-001, 0.300" Wide

## Connection Diagram



MM74C908 Dual CMOS 30-Volt Relay Driver

**Absolute Maximum Ratings**(Note 1)

Voltage at any Input Pin	−0.3V to $V_{CC} + 0.3V$
Voltage at any Output Pin	32V
Operating Temperature Range	−40°C to +85°C
Operating $V_{CC}$ Range	4V to 18V
Absolute Maximum $V_{CC}$	19V
$I_{SOURCE}$	500 mA
Storage Temperature Range ( $T_S$ )	+150°C
	−65°C to +150°C

Lead Temperature ( $T_L$ )

(Soldering, 10 seconds)

260°C

Power Dissipation ( $P_D$ )

Refer to Maximum Power

Dissipation vs Ambient

Temperature Graph

**Note 1:** "Absolute Maximum Ratings" are those values beyond which the safety of the device cannot be guaranteed. Except for "Operating Temperature Range" they are not meant to imply that the devices should be operated at these limits. The Electrical Characteristics table provides conditions for actual device operation.

**DC Electrical Characteristics**

Min/Max limits apply across temperature range, unless otherwise noted

Symbol	Parameter	Conditions	Min	Typ	Max	Units
<b>CMOS TO CMOS</b>						
$V_{IN(1)}$	Logical "1" Input Voltage	$V_{CC} = 5V$ $V_{CC} = 10V$	3.5 8.0			V V
$V_{IN(0)}$	Logical "0" Input Voltage	$V_{CC} = 5V$ $V_{CC} = 10V$			1.5 2.0	V V
$I_{IN(1)}$	Logical "1" Input Current	$V_{CC} = 15V, V_{IN} = 15V$		0.005	1.0	$\mu A$
$I_{IN(0)}$	Logical "0" Input Current	$V_{CC} = 15V, V_{IN} = 0V$	−1.0	−0.005		$\mu A$
$I_{CC}$	Supply Current	$V_{CC} = 15V$ , Outputs Open Circuit		0.05	15	$\mu A$
	Output "OFF" Voltage	$V_{IN} = V_{CC}, I_{OUT} = -200 \mu A$		−30		V
<b>CMOS/LPTTL INTERFACE</b>						
$V_{IN(1)}$	Logical "1" Input Voltage	$V_{CC} = 4.75V$	$V_{CC} - 1.5$			V
$V_{IN(0)}$	Logical "0" Input Voltage	$V_{CC} = 4.75V$			0.8	V
<b>OUTPUT DRIVE</b>						
$V_{OUT}$	Output Voltage	$I_{OUT} = -300 mA, V_{CC} \geq 5V, T_J = 25^\circ C$ $I_{OUT} = -250 mA, V_{CC} \geq 5V, T_J = 65^\circ C$ $I_{OUT} = -175 mA, V_{CC} \geq 5V, T_J = 150^\circ C$	$V_{CC} - 2.7$ $V_{CC} - 3.0$ $V_{CC} - 3.15$	$V_{CC} - 1.8$ $V_{CC} - 1.9$ $V_{CC} - 2.0$		V V V
$R_{ON}$	Output Resistance	$I_{OUT} = -300 mA, V_{CC} \geq 5V, T_J = 25^\circ C$ $I_{OUT} = -250 mA, V_{CC} \geq 5V, T_J = 65^\circ C$ $I_{OUT} = -175 mA, V_{CC} \geq 5V, T_J = 150^\circ C$		6.0 7.5 10	9.0 12 18	$\Omega$ $\Omega$ $\Omega$
	Output Resistance Coefficient			0.55	0.80	%/ $^\circ C$
$\theta_{JA}$	Thermal Resistance	(Note 2)		100	110	$^\circ C/W$
	MM74C908	(Note 2)		45	55	$^\circ C/W$

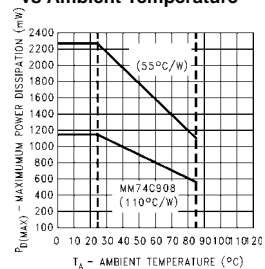
**Note 2:**  $\theta_{JA}$  measured in free air with device soldered into printed circuit board.**AC Electrical Characteristics** (Note 3)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
$t_{pd1}$	Propagation Delay to a Logical "1"	$V_{CC} = 5V, R_L = 50\Omega$ , $C_L = 50 pF, T_A = 25^\circ C$ $V_{CC} = 10V, R_L = 50\Omega$ , $C_L = 50 pF, T_A = 25^\circ C$		150 65	300 120	ns ns
$t_{pd0}$	Propagation Delay to a Logic "0"	$V_{CC} = 5V, R_L = 50\Omega$ , $C_L = 50 pF, T_A = 25^\circ C$ $V_{CC} = 10V, R_L = 50\Omega$ , $C_L = 50 pF, T_A = 25^\circ C$		2.0 4.0	10 20	$\mu s$ $\mu s$
$C_{IN}$	Input Capacitance	(Note 4)		5.0		pF

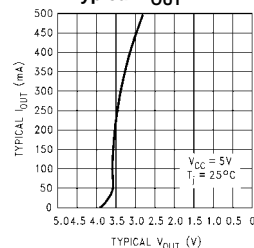
**Note 3:** AC Parameters are guaranteed by DC correlated testing.**Note 4:** Capacitance is guaranteed by periodic testing.

## Typical Performance Characteristics

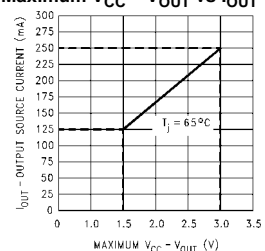
**Maximum Power Dissipation vs Ambient Temperature**



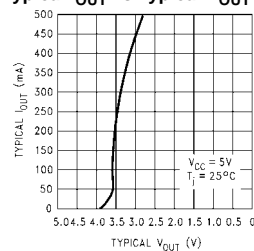
**Typical  $I_{OUT}$  vs Typical  $V_{OUT}$**



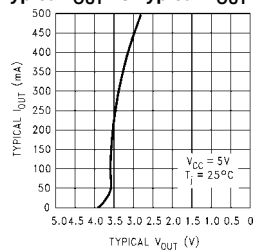
**Maximum  $V_{CC} - V_{OUT}$  vs  $I_{OUT}$**



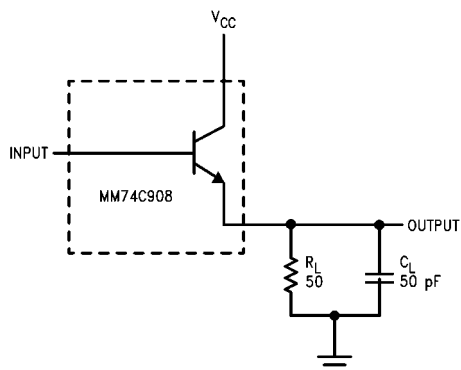
**Typical  $I_{OUT}$  vs Typical  $V_{OUT}$**



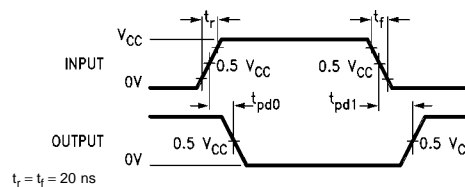
**Typical  $I_{OUT}$  vs Typical  $V_{OUT}$**



## AC Test Circuit



## Switching Time Waveforms



## Power Considerations

### Calculating Output "ON" Resistance ( $R_L > 18\Omega$ )

The output "ON" resistance,  $R_{ON}$ , is a function of the junction temperature,  $T_J$ , and is given by:

$$R_{ON} = 9 (T_J - 25) (0.008) + 9: \quad (1)$$

and  $T_J$  is given by:

$$T_J = T_A + P_{DAV} \theta_{JA}: \quad (2)$$

where  $T_A$  = ambient temperature,  $\theta_{JA}$  = thermal resistance, and  $P_{DAV}$  is the average power dissipated within the device.  $P_{DAV}$  consists of normal CMOS power terms (due to leakage currents, internal capacitance, switching, etc.) which are insignificant when compared to the power dissipated in the outputs. Thus, the output power term defines the allowable limits of operation and includes both outputs, A and B.  $P_D$  is given by:

$$P_D = I_{OA}^2 R_{ON} + I_{OB}^2 R_{ON}: \quad (3)$$

where  $I_O$  is the output current, given by:

$$I_O = \frac{V_{CC} - V_L}{R_{ON} + R_L} \quad (4)$$

$V_L$  is the load voltage.

The average power dissipation,  $P_{DAV}$ , is a function of the duty cycle:

$$P_{DAV} = I_{OA}^2 R_{ON} (\text{Duty Cycle}_A) + I_{OB}^2 R_{ON} (\text{Duty Cycle}_B) \quad (5)$$

where the duty cycle is the % time in the current source state. Substituting equations (1) and (5) into (2) yields:

$$T_J = T_A + \theta_{JA} [9 (T_J - 25) (0.008) + 9]: \quad (6a)$$

$$[I_{OA}^2 (\text{Duty Cycle}_A) + I_{OB}^2 (\text{Duty Cycle}_B)]$$

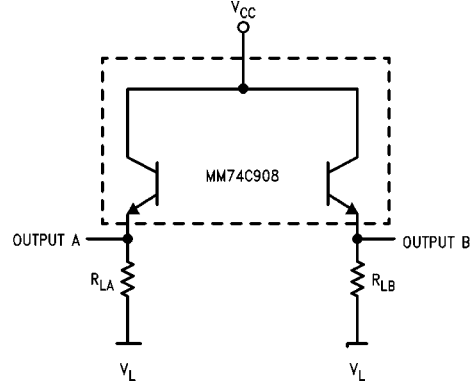
simplifying:

$$T_J = \frac{T_A + 7.2 \theta_{JA} [I_{OA}^2 (\text{Duty Cycle}_A) + I_{OB}^2 (\text{Duty Cycle}_B)]}{1 - 0.072 \theta_{JA} [I_{OA}^2 (\text{Duty Cycle}_A) + I_{OB}^2 (\text{Duty Cycle}_B)]}$$

## Applications

(See AN-177 for applications)

Equations (1), (4), and (6b) can be used in an iterative method to determine the output current, output resistance and junction temperature.



For example, let  $V_{CC} = 15V$ ,  $R_{LA} = 100\Omega$ ,  $R_{LB} = 100\Omega$ ,  $V_L = 0V$ ,  $T_A = 25^\circ C$ ,  $\theta_{JA} = 110^\circ C/W$ ,  $\text{Duty Cycle}_A = 50\%$ ,  $\text{Duty Cycle}_B = 75\%$ .

Assuming  $R_{ON} = 11\Omega$ , then:

$$I_{OA} = \frac{V_{CC} - V_L}{R_{ON} + R_{LA}} = \frac{15}{11 + 100} = 135.1 \text{ mA},$$

$$I_{OB} = \frac{V_{CC} - V_L}{R_{ON} + R_{LB}} = 135.1 \text{ mA}$$

and

$$T_J = \frac{T_A + 7.2 \theta_{JA} [I_{OA}^2 (\text{Duty Cycle}_A) + I_{OB}^2 (\text{Duty Cycle}_B)]}{1 - 0.072 \theta_{JA} [I_{OA}^2 (\text{Duty Cycle}_A) + I_{OB}^2 (\text{Duty Cycle}_B)]}$$

$$T_J = \frac{25 + (7.2) (110) [(0.1351)^2 (0.5) + (0.1351)^2 (0.75)]}{1 - (0.072) (110) [(0.1351)^2 (0.5) + (0.1351)^2 (0.75)]}$$

$$T_J = 52.6^\circ C$$

$$\text{and } R_{ON} = 9 (T_J - 25) (0.008) + 9$$

$$= 9(52.6 - 25) (0.008) + 9 = 11\Omega$$

**Physical Dimensions** inches (millimeters) unless otherwise noted